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Online Educational Game for Interior Design with Design Thinking Process and Multidimensional Scaffolding

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Abstract: Modern interior design relies on design thinking to tackle complex ethical, environmental, and technological challenges with strategic and innovative solutions. While design thinking is widely valued in interior design education, instructors often find it difficult to teach, and students struggle to grasp and apply these concepts effectively. Research indicates that educational games can improve learners' understanding and application of design thinking, especially for complex problem-solving and learning transfer. This study introduces a game-based learning approach within interior design context, using multidimensional scaffolding and techniques like Empathy Map and Floor Plan to build design thinking competency. Players role-play as novice interior designers, interacting with NPCs to gather information and guidance (scaffolding) to complete game missions. Flow and anxiety levels were measured among 15 participants, showing high flow scores and low anxiety. Preliminary findings suggest this game-based approach is an effective tool for interior design education.

Keywords: digital game-based learning, interior design, design thinking, scaffolding

1. Introduction

Interior design relies on design thinking to create innovative solutions that push creative boundaries (Sultan & Qaed, 2020). This approach is crucial as interior design is constantly influenced by technological advancements, societal changes, and cultural shifts (Rashdan & Ashour, 2022). However, students often struggle to apply them effectively (Rengel, 2014). Plattner et al., (2012) note that traditional teaching focus on individual parts rather than the whole system, can hinder students' ability to connect themes. Therefore, in interior design education, it's crucial to balance inquiry and reflective practice by integrating knowledge and application within realistic contexts to foster learning transfer (Friedman, 2000;).

Research shows that educational games effectively enhance learners' understanding and application of design thinking (Kloeckner et al., 2021) and facilitating learning transfer (Hou, 2023). Incorporating realistic contexts into game-based learning engages learners in authentic environments, encouraging inquiry and reflective practice (Yeoh et al., 2024). However, completing realistic interior design tasks can be challenging, requiring scaffolding to help learners navigate difficulties during practice (Bell et al., 2005). Hou (2023) suggests that multidimensional scaffolding within games can optimize learners' cognitive experiences.

This game is set in a realistic interior design context, where learners role-play as novice designers at the start of their careers. The game is designed to guide learners through the key stages of design thinking – empathize, define, ideate, prototype and test, using an interactive environment supported by procedural and cognitive scaffolding to enhance learning. Learners begin by interacting with NPC who act as client to gather their needs and preferences. Tool like the Empathy Map is given in the game and serves as a cognitive scaffold, allowing learners to organize client information and consider the user's problem and inner needs, fostering a core design thinking skills of define and empathize. Learners prototype their designs by exploring creative solution using the Supplier Database and Floor Plan embedded in the game interface (Figure 1). The Floor Plan assist with spatial organization while other

NPCs acts as procedural scaffolding, helping learners iterate on their design. The main objective is for learners to learn design thinking concepts through NPC dialogue and exploration, and to apply this knowledge to create a prototype that best meets customer needs, thereby enhancing their design thinking skills.

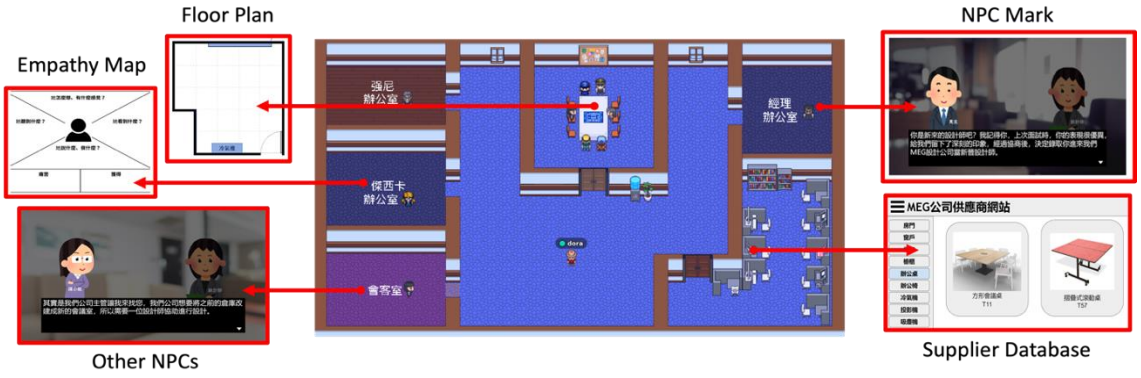

Figure 1. Leaners explore the game's scene with multidimensional scaffoldings through tools like the Empathy Map, Floor Plan, Database and NPC interactions.

2. Method

Fifteen adults were recruited for this study. The experiment began with a 10-minutes facilitator-led briefing that introduce the game rules, objectives and the scaffolding that would guide them throughout the game. Following the introduction, participants engaged in a 60-minutes gameplay session. Afterward, participants completed a 15 minutes questionnaire on flow and learning anxiety. Participants' flow experiences were assessed using Kiili's (2006) Flow Scale, a 22-item questionnaire rated on a 5-point Likert scale, which showed high internal consistency (Cronbach's alpha = 0.945). Anxiety was measured using Krashen's (1987) Affective Filter Hypothesis, with an 8-item, 5-point Likert scale demonstrating good reliability (Cronbach's alpha = 0.748).

3. Results

Table 1 presents the results of the Mann-Whitney U test on the learners' flow experience and anxiety after completing the game. The mean values for Overall Flow (M=3.90, SD=0.68), Flow Antecedents (M=3.84, SD=0.73), Flow Experience (M=3.94, SD=0.74), and other dimensions were all significantly higher than the scale's median (i.e., 3), except for Action–awareness merging. This indicates that the game effectively keeps learners engaged in the tasks. Killi (2006) highlights the challenge of balancing action-awareness merging in educational games, as constructing new knowledge requires cognitive thinking processes, which can disrupt the gaming experience.

The overall anxiety (M=2.15, SD=1.10) was significantly lower than the median of the scale (i.e., 3), suggesting that the game elicited low anxiety among learners. Wang et al. (2015) suggest that an appropriate level of anxiety enhance learners' attention and motivation, indicates that the game generated appropriate level of anxiety for learning.

Table 1. *Flow and Learning Anxiety Descriptive Statistical Analysis (n = 15)*

Dimension	*M*	*SD*	*Z*	*p*
Overall Flow	3.90	0.68	2.99**	0.003
Flow Antecedents	3.84	0.73	3.38***	0.001
Challenge-skill balance	4.03	0.92	3.39***	0.001
Goals of an activity	3.70	1.13	2.71**	0.007
Unambiguous Feedback	4.07	0.73	4.07***	0.001

Control	4.27	0.65	4.75***	0.001
Action–awareness merging	3.13	0.95	1.73	0.083
Flow Experience	3.94	0.74	3.00**	0.003
Concentration	3.98	0.96	3.39***	0.001
Time distortion	4.03	0.72	4.49***	0.001
Autotelic experience	3.80	0.92	3.67***	0.001
Loss of self-consciousness	4.07	1.08	3.11**	0.002
Learning Anxiety	2.15	1.10	2.70**	0.007

$^{**}p < 0.01$

4. Conclusion

This study introduces a game-based learning approach utilizing the context of interior design and multidimensional scaffolding to develop learners' design thinking competency. The above data show that the flow is higher than the scale's median (i.e. 3) and anxiety is significantly lower than the median of the scale. Preliminarily, the game design of this study increases the flow of learners and elicited low anxiety during learning, assisting learners in developing design thinking concepts and skills. For future studies, more sample sizes can be included, as well as a more in-depth comparative analysis of motivation, learning effectiveness, the usefulness of the game scaffolding, and game fidelity.

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